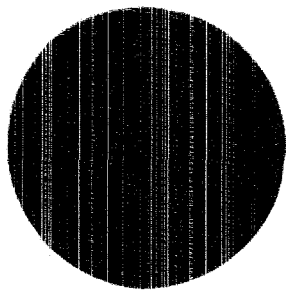
THE ATOM

Los Alamos Scientific Laboratory

April, 1970



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THE ATOM

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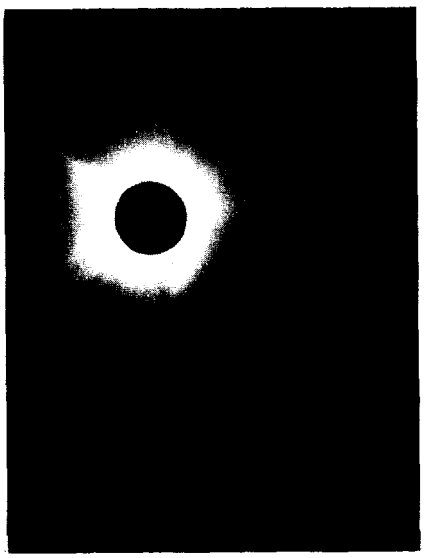
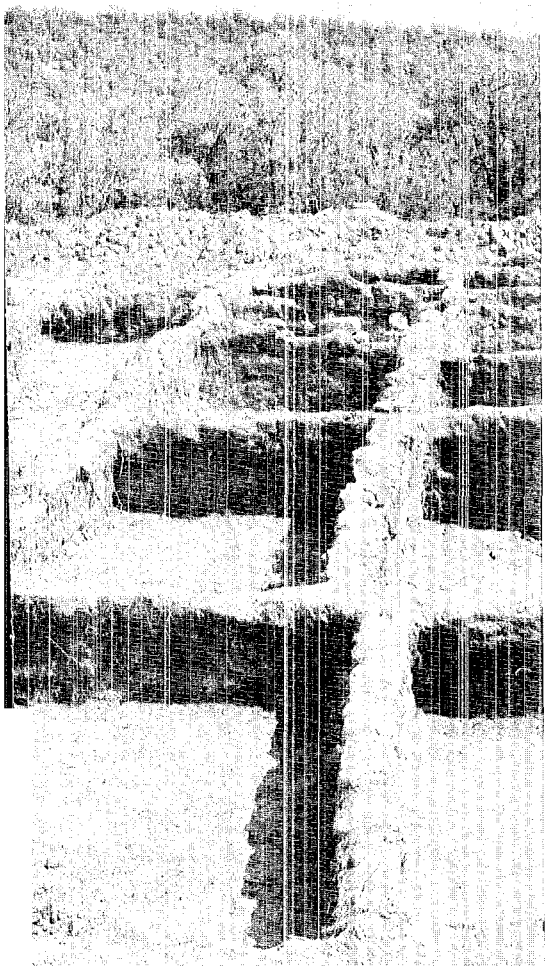


COVER:
Bright streamers poured from the solar corona for millions of miles into space during the March 7 eclipse. This photograph, made through a radially symmetric neutral density filter to compensate for the steep decline of coronal brightness from the sun's edge outward, shows one streamer in the upper left out to more than seven solar radii on the negative. The photograph and others were taken by PUB-1 Group Leader Bill Regan. His story, "Night Before Noon," begins on page 12.

FRED WORMAN

biologist turned archeologist

By Bill Richmond



Zia workmen under the supervision of Worman excavated this site on Mesita del Buey in 1957. D-8 photograph.

Visualize the Pajarito Plateau 800 years ago. It's a beautiful summer morning and a small band of Pueblo Indians from the Little Colorado River area of Arizona are nearing the end of a journey of hundreds of miles.

These Indians walked down the Little Colorado, entered what is now New Mexico in the area of Acoma and walked up the Rio Puerco. They may have spent the previous night along the banks of the Rio Grande but, in any event, when they saw the Pajarito Plateau they decided: "This is where we will settle."

This was the first known migration to the plateau upon which today stands one of the world's greatest research centers—the Los Alamos Scientific Laboratory.

That we know as much as we do about the first residents of this plateau at the foot of the Jemez Mountains is largely due to the efforts of one man—Fred Worman. Worman, H-DO, is the official archeologist for both LASL and the Nevada Test Site northwest of Las Vegas.

"My interest in anthropology actually began when I was a 16-year-old kid in Arizona and working on digs with archeologists, so I was really working in the field before I started my formal education," Worman says. "Also, the ranch where I was raised in Arizona had lots of ruins and I became inter-

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Worman exposes a fire pit in a kiva found at TA-46 before the area was made into a parking lot. D-8 photograph.

ested in them and wanted to learn more about them."

Worman graduated from high school in the midst of the depression, and, like many of that era, could not afford college. So he ended up in the mining fields. But then he got married "and my wife talked me into enrolling in college . . . at the age of 28 . . . and as a freshman. I had a job and hated to make the break from a sure thing—a good job where I was getting paid—to something unknown."

However, after Worman began his college work, he stayed until he received his graduate degree from the University of New Mexico.

"I took biology instead of anthropology because during the depression the biologists were eating and the anthropologists were not. Also, I thought I would probably end up teaching in a high school somewhere. Biology was a high school subject; anthropology was not. As it turned out, however, I never did teach in high school."

In any event, many of the courses required for a degree in biology were also required for anthropology majors. Thus, Fred was able to combine practicality with his chief interest.

After receiving his master's degree from UNM, Worman accepted a teaching post at Adams State College in Alamosa, Colo.

"I started as a biology teacher. Through the years a department of anthropology was established and by the time I came to the Laboratory in 1950 I was head of the department."

Fred had worked three summers on field trips with his students at Bandelier National Monument. Among their projects was the excavation and stabilization of Rainbow House. He liked this area and when the opportunity appeared in 1950 to join the Laboratory—as a biologist—he took it.

However, Worman's experience in archeology was utilized by the Laboratory in addition to his biological training. In accordance with the Federal Antiquities Act, all ruins must be protected or excavated when they are going to be disturbed. And since LASL was embarking on a building program, Worman was delegated to go into an area ahead of the construction people and conduct an archeological search.

"ENG-3 does the mapping for me and D-8 does the documentary photography," Worman says. "Zia personnel help with the labor at Los Alamos and at NTS I use REECo personnel. Some of the Zia people have been working with me for 15 years."

Worman noted that he and his crew normally have sufficient time to conduct a thorough investigation of the sites before the bulldozers come in. The usual procedure is to place the primary emphasis on those areas where construction work will take place. In the event there are adjacent areas which may contain artifacts—and where there is no danger of their being disturbed—Fred will wait un-

Worman sizes an artifact with calipers and then records the information.

til he has more time before digging there.

"We don't screen everything here (sifting the soil through a fine mesh screen) although we do at NTS," Worman said. "Screening takes three to five times as long to do. This is the sole difference between what we do and what is normally referred to as classical archeology."

In Los Alamos the archeological sites are such things as buildings and dwellings while at NTS they are usually caves. Worman considers a ruin as something substantial like a room or building, not simply a hearth.

What happens to the artifacts found?

Typological artifacts (representing a culture of the country) that are found in Los Alamos are kept here or sent to the Museum of New Mexico in Santa Fe. Those found at NTS are sent to the Museum of

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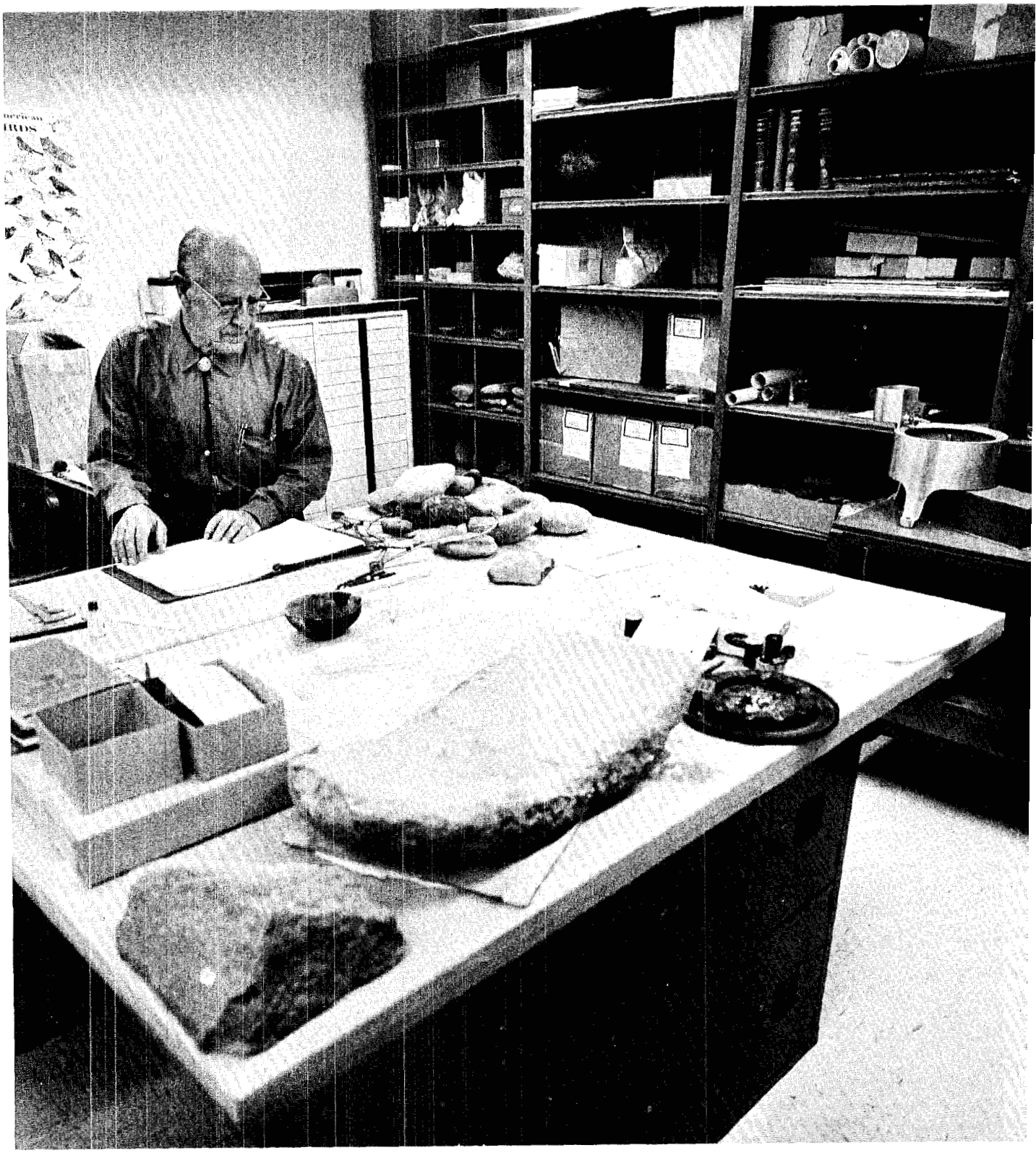
In his workshop at the Occupational Health Laboratory, Worman records data pertaining to artifacts he has found.



Nevada in Carson City or the University of Nevada at Las Vegas. Fred cleans the material, prepares a description of it, writes a report describing it and its history and then returns it as property of the state where it was found.

He has also been to Amchitka where it was determined that no archeology was required as far as AEC projects were concerned. The Aleuts lived near the coast while the AEC projects are on the spine of the Island. However, there was a little vandalism to sites by some of the workers on the Island so there were a number of digs by archeologists with Fred serving as a consultant.

Although many of the excavated sites in Los Alamos are behind a security fence, one is in the middle of town for all to inspect—located northeast of The Lodge. This site was excavated by Worman and a group of high school students in cooperation with the Los Alamos Archeological Society.

"We excavated and stabilized but did no restoration. We probably spent about seven years on this site, working on weekends." When an archeologist excavates he digs out the loose soil; when he stabilizes he reinforces the walls and structures so they will not crumble; when he restores he attempts to rebuild the structure as it was when occupied.

One of the largest archeological undertakings at Los Alamos was the dig on Mesita del Buey which provided a great deal of knowledge about the first migration to the Pajarito Plateau.

In the mid-1950's it became apparent that the Laboratory required more space for the disposal of contaminated materials. These materials are disposed of in huge pits measuring 600 feet long, 100 feet wide and 25 feet deep.

Fred and his crew went into the area and uncovered 11 ruins.

The first known migration to the Pajarito Plateau was between 1150 and 1200 A.D. These people were the Pueblo Indians. "We know of no specific reason why they came here," Worman says, "but it was probably because they were looking for new lands and abundant water. These were the ancestors of the people who speak the Keresan language. They built small-house pueblos and made black-on-white pottery.

"About 1300, after a great 26-year drought in Arizona and Colorado, there was a second migration to the Los Alamos area. These were Tewa people who came here from the Mesa Verde in Colorado and Chaco Canyon in New Mexico. These were good water years on the Rio Grande. These people built the large sites such as Tsankawi, Otowi, Tsirege (off Pajarito Road near its intersection with State Road 4) and Navawi.

"The early pueblos were abandoned about 1350 and people moved to Frijoles Canyon.

"By 1550 all the ruins on the Pajarito Plateau had been abandoned for sites along the Rio Grande. This was primarily due to a climatic change—the weather became colder and the corn-growing season became too short. Over 6,600 feet, corn is a marginal crop anyway and a few degrees change in temperature eliminates the possibility of growing corn at the elevation of Los Alamos."

All those people who migrated here were peaceful types. At times they numbered in the thousands, perhaps as high as 5,000.

"The early people here did not move down to the Rio Grande because of raiding by warlike Navajos or Utes," Worman said, "although for years we thought they did."

In contrast with the relatively short archeological history of Los Alamos, the Nevada Test Site has 11,500 years of such history. It begins with the Clovis man about 9,500 B.C. Clovis material has been found in other areas of Nevada—such as Tonopah—in addition to NTS.

"There was some movement of Pueblo culture to this territory, probably by trading parties," Worman said. From 1150 A.D. to historical time (early 1900's) the area was Paiute Indian Territory.

Archeologists do not deal exclusively with the past, however, and Worman outlined a couple of future projects.

"We plan to try obsidian dating," he said.

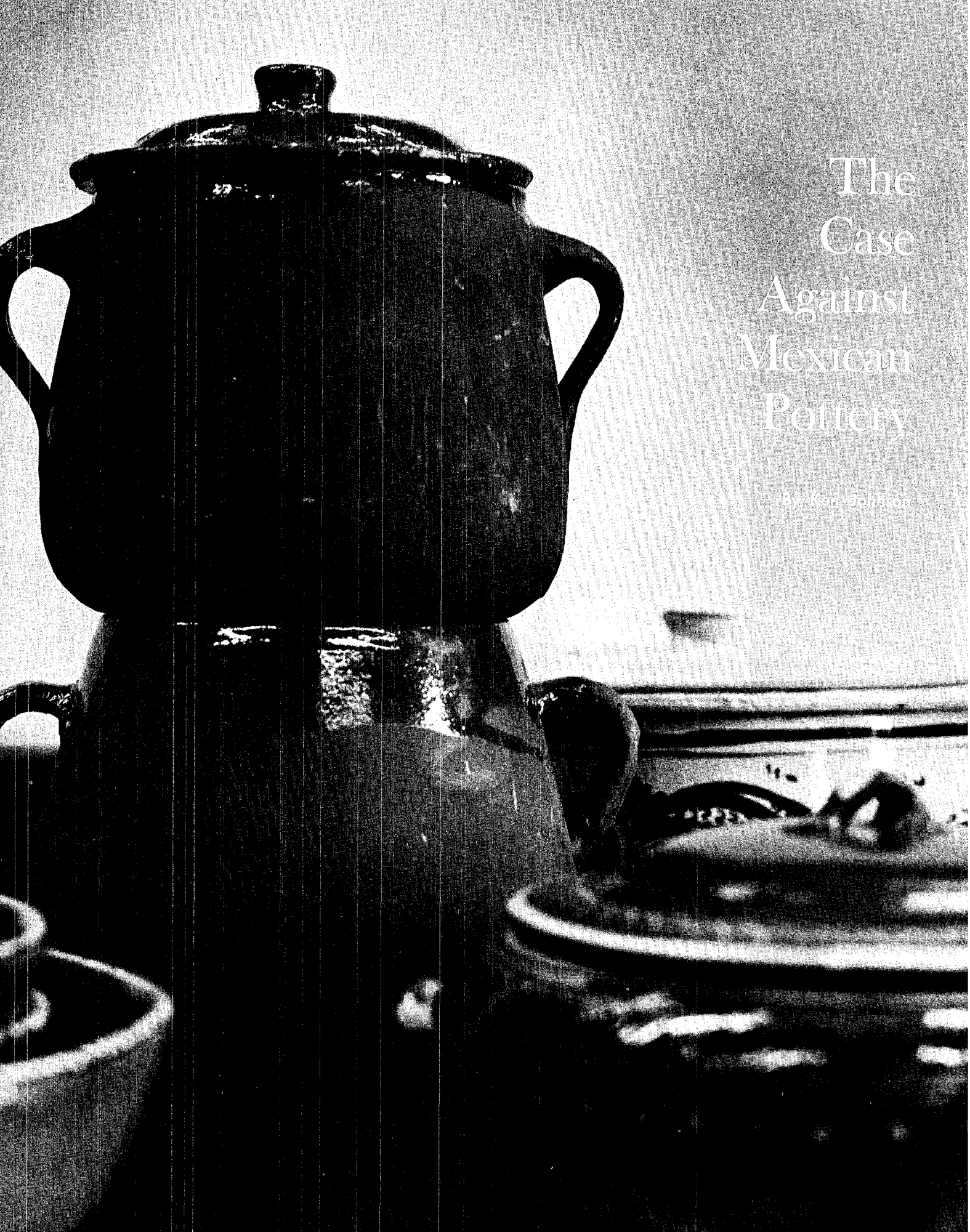
When obsidian is tooled or broken to form artifacts, the newly exposed surface absorbs water very slowly and a hydration layer forms. By measuring this layer, it is possible to date the time when the obsidian was made into an artifact.

"One micron represents about 100 years in a desert culture," Worman said. "In a temperate zone absorption is a little more rapid and the layer is a little thicker for the same amount of time. We are setting up the equipment now for obsidian dating and hope to have it in operation in a few months."

Another contribution to the field of archeology that can be made by LASL was explained by Worman: "We can expose pottery to the water boiler reactor, bombard it with neutrons, run a sample on an analyzer and determine via nondestructive testing the components of the pottery. This is known as neutron activation study.

"By this method we can learn many things. Such as where the clay to make the pottery came from; the different kinds of pottery clay; what the trading habits were among the various tribes; what the glaze on the pottery is made of; who made a particular piece of pottery if it is not native to the tribe or area where found; and much more."

Thus, LASL will help to unlock the secrets of ancient man and his materials using modern tools.



The Case Against Mexican Pottery

By Ken Johnson

In the wake of an isolated, but dramatic, case of lead poisoning from Mexican pottery, industrial, state and federal agencies are taking steps to prevent similar occurrences.

The case in point happened in California where a young physician and his family were suffering the ill effects of lead poisoning—frequent stomach cramps, fatigue, muscular weakness, and one of the children suffered temporary paralysis of one side of his body. The villain, discovered only after many days of futile and desperate searching, was a Mexican pottery pitcher from which the family's daily servings of orange juice were poured.

There is nothing new about lead poisoning from dinnerware. There are knowledgeable persons who even credit it with the catastrophic downfall of the Roman Empire. But through the years, potters have learned to make glazes that obviate the possibility of lead poisoning.

Lead poisoning is cumulative. A person can take a large dose of lead without suffering ill effects because like a coffee cup which can accept only so much coffee from the pot before it spills over, the human body will accept only so much lead at a time and the rest of it is passed out as waste.

Mexican pottery is a part of the decor in many homes in the United States, but mostly in the southwest. It has been brought into the country by vacationers returning from Mexico and has also been shipped to many commercial vendors in the United States for sale to the public.

Recent nationwide publicity about the California incident has resulted in mounting concern regarding use of Mexican pottery for food. Locally, the Los Alamos Scientific Laboratory's Health division issued an office memorandum pertaining to the use and treatment of it for the benefit of employees, many of whom use the pottery both for decoration and for food.

The memorandum warns that if this pottery is used daily for an extended period, symptoms of lead poisoning can develop, although occasional use would cause no problem except to those persons who are sensitive to lead because of other illnesses.

The method recommended in the memorandum for pretreating pottery is to first wash it with soap and water; fill it with a mixture of one cup of vinegar for each cup of water and allow it to stand overnight. Then, rinse it well, dry it, coat it with grease and heat it in an oven to 150 degrees.

"This treatment," it is stated, "is satisfactory for vessels used in serving of hot or cold foods, but is of little value when the vessel is used as a cooking utensil. The use of Mexican pottery (of the soft sort) for cooking is not recommended without thorough testing of the glaze for absence of soluble lead compounds."

This recommendation by the Laboratory to its employees was the result of a study of Tonala Mexican pottery conducted in 1965 by Evan Campbell, H-5 Bioanalytical section leader.

The study came about as the result of interest by the late Thomas Shipman, then Health division leader. Shipman ordered an analysis of Tonala Pottery after talking with a health expert of the lead industry who questioned the possibility of lead intoxication from its use. Shipman and a representative of the New Mexico State Health Department acquired several pieces of this pottery from a local vendor. The vendor donated it for the purpose of a laboratory study to determine if quantities of lead could be extracted from it.

The Laboratory's interest in determining if the pottery was safe for use was based on the fact that many of the Laboratory's employees were known to have pottery of the same type in their homes, most of which was used for decoration, but some that was used for food, at least on an occasional basis.

Campbell conducted the study with the assistance of Mary Bieri, now of H-7, and Helen Miller, who has since retired. The pottery was of two types: one was a brown ware and the other a white or cream ware.

In both cases, the study indicated the glaze is of a poor quality and is carelessly applied to the clay. It has many pitholes and is thin in some areas, and the clay itself is very porous, brittle and lightweight.

Campbell first treated the pottery in accordance with the instructions that came with it: "The Tonala Indian Pottery (Mexico) contained in this shipment is a soft glaze. When it is first used the flavor of the clay will be noticed. To eliminate this taste treat the pottery as follows:

"All bake dishes, casseroles, bean pots and other cooking ware may be greased well and placed in a hot oven for about 30 minutes. This will take out the clay odor.

"Rinse well with plain baking soda and water.

"Pottery not so treated will rid itself of any foreign flavor after a little use."

After complying with these instructions, Campbell poured a solution of acetic acid into the pottery pieces and heated them in an oven. The acid solutions were then analyzed for lead content.

The pottery was then washed with a detergent and rinsed with tap water (similar to household washing), rinsed with distilled water to remove any lead background, and eluted with an aqueous solution of ammonia to simulate an alkaline food preparation.

Significant amounts of lead were extracted by the acetic acid solution, although the amounts were less with each subsequent repeat of the process. The ammonia treatment did not extract significant quantities of lead.

From this study, Campbell determined that pretreatment of Tonala Pottery with lard may remove the odor of the clay, but it does not prevent the leaching of lead by acid solutions, which in the household would include such liquids as orange juice. "No treatment will

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Evan Campbell, H-5 Bioanalytical section leader, displays the Tonala Mexican pottery used in his 1965 study. He was able to leach lead from the glaze of all of it.

insure that improperly glazed ceramic ware is safe for food," he said.

It was also determined that any lead intoxication problem would stem from the glaze. Campbell's report was presented at an Mexican-American Border Conference on Public Health in 1966 and was translated by Mexican officials for circulation in their country.

Forrest Strong, an art teacher at Cumbres Junior High School in Los Alamos and locally-accepted authority on pottery, explained why lead might be extracted from this glaze. Strong, who holds a master's degree with a major in pottery and periodically teaches a night course in pottery for adults, said a mixture of silica and lead oxide can be used in making pottery glaze. The lead melts at low temperature and enters into a chemical reaction with the silica to form the glaze. If the mixture is not heated at a high enough temperature the lead melts but the necessary reaction with the silica does not take place. Strong noted there are high concentrations of silica in potter's clay and a glaze can be made by adding lead oxide to the surface of the pottery, firing it, and depending upon the necessary chemical reaction between the silica in the clay and the lead additive to form the glaze.

Pottery made in the United States, Strong said, is all fired at high temperatures and a majority of potters use materials other than lead in glazing. Indian pottery made in New Mexico, he said, is not glazed at all. It is a mixture of fine clay and water which is polished with a smooth rock.

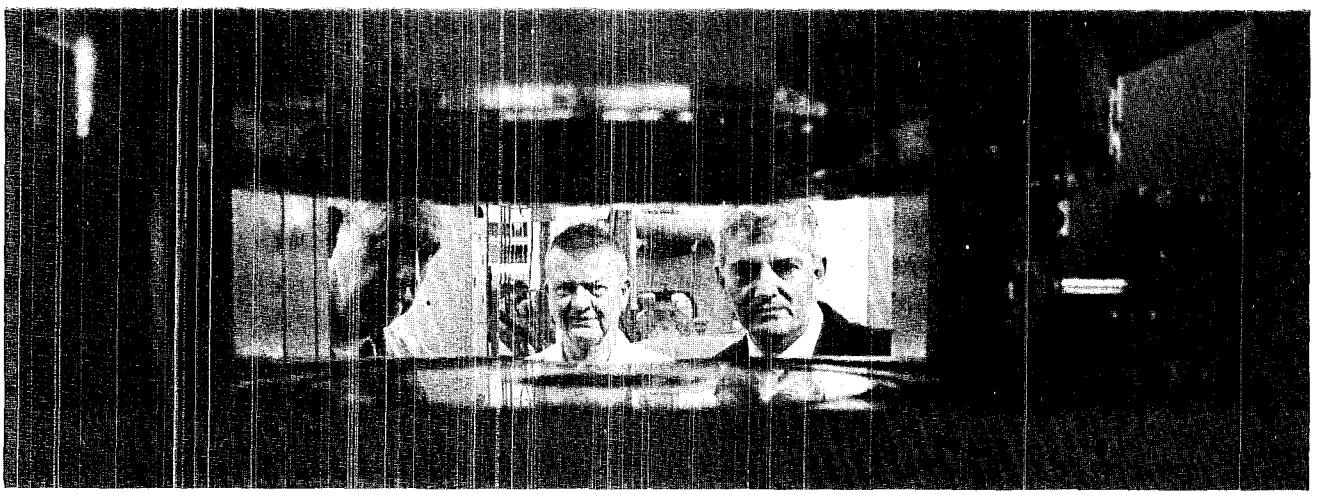
Not long after the Laboratory issued its memorandum to employees, the U.S. Food and Drug Administration released a warning to consumers not to use Mexican pottery for food and asked merchants to remove all Mexican pottery from their shelves. The FDA warning was followed by border inspections by U.S. Custom's officials for pottery being imported from Mexico to the United States through El Paso. All Mexican pottery being imported is being examined in the FDA laboratories in Dallas, Texas. The pottery from which lead can be leached is not allowed to enter this country.

This action does not constitute an embargo since commercial shipments tested and found to be safe are being allowed to enter the United States. Mexican authorities are cooperating in this program.

The FDA warning has also been transmitted to county sanitation officials in New Mexico to help them in making replies to local inquiries, according to Carl Henderson, chief of the Consumer Protection Section of the New Mexico Health and Social Services Department.

Said Henderson, "The safest method of dealing with this pottery is for those who have it to destroy it. But, if homeowners want to keep it for ornamental purposes it should be labeled." Henderson suggested that the pottery can be labeled on its base with words "something to the effect that 'This pottery is for ornamental purposes and is not to be used for food.' " He suggested that the pottery be marked with India ink or with a typed label held in place with an adhesive. The reason for labeling the pottery, he said, is so that in subsequent years if it is handed down to friends or relatives, they will know it is not safe for use with foods.

What does Project Rover have in common with the first wheel and axle?



Bob Keil and Gale Hanks, both of CMB-6, explain an innovation on a hydraulic press to Samuel Snyder, SNPO. The innovation is a safety stop on either side of the gap through which the three men are looking. The stops are automatically emplaced between the top (forming chamber) and the bottom (pressure ring) when the press is not cycling. With this innovation press operators can safely work between chamber and pressure ring when necessary.

If use of the wheel and axle had been limited to the vehicles pulled by oxen and horses, we would still be living in a very primitive world. But it wasn't.

The wheel-axle combination is used in so many ways today that it is taken for granted. It is used on the automobile and the bicycle. The dial on your telephone, some of the interworkings of your alarm clock, and even the door knob, are outgrowths of the first wheel and axle.

This phenomenon, finding uses for something beyond that for which it was invented, is called "spin-off." For seven years, the National Aeronautics and Space Administration (NASA) has had a program through which it makes available to industry the technology developed in the space programs. Authorized under the Space Act, the program is known as Technology Utilization, or "TU." One of the most recent examples of TU stems from Project Rover at the Los Alamos Scientific Laboratory.

Project Rover is America's program to develop a nuclear propelled rocket. It is a joint AEC-NASA program administered by the Space Nuclear Propulsion Office (SNPO). The scientific and technological aspects of the reactor portion of the project have been the responsibility of the Los Alamos Scientific Laboratory.

Since this project began at Los Alamos about 15 years ago, Laboratory scientists have markedly expanded nuclear reactor technology. Might the public, and other government and industrial agencies, be able to use some of this technology in other ways?

Of recent there has been a notable effort toward finding out.

Samuel Snyder, NASA technology utilization officer from SNPO, spent eight days at LASL working with members of D-6 and N, J and CMB divisions to determine what Rover technology would be of benefit to our nation's economy.

"My visit here is a new TU experiment," said Snyder. "To my knowledge, it is the first time that an 'outsider' has come into a Laboratory such as LASL to find things that could be announced to the public.

"We know many things are discovered, invented and innovated at the Laboratory that can be used by the public. There is an agreement between the AEC and LASL that information such as this from the nuclear rocket program should be reported. But to do this is a full-time effort on somebody's part and funds haven't been available to LASL to do it. For this reason,

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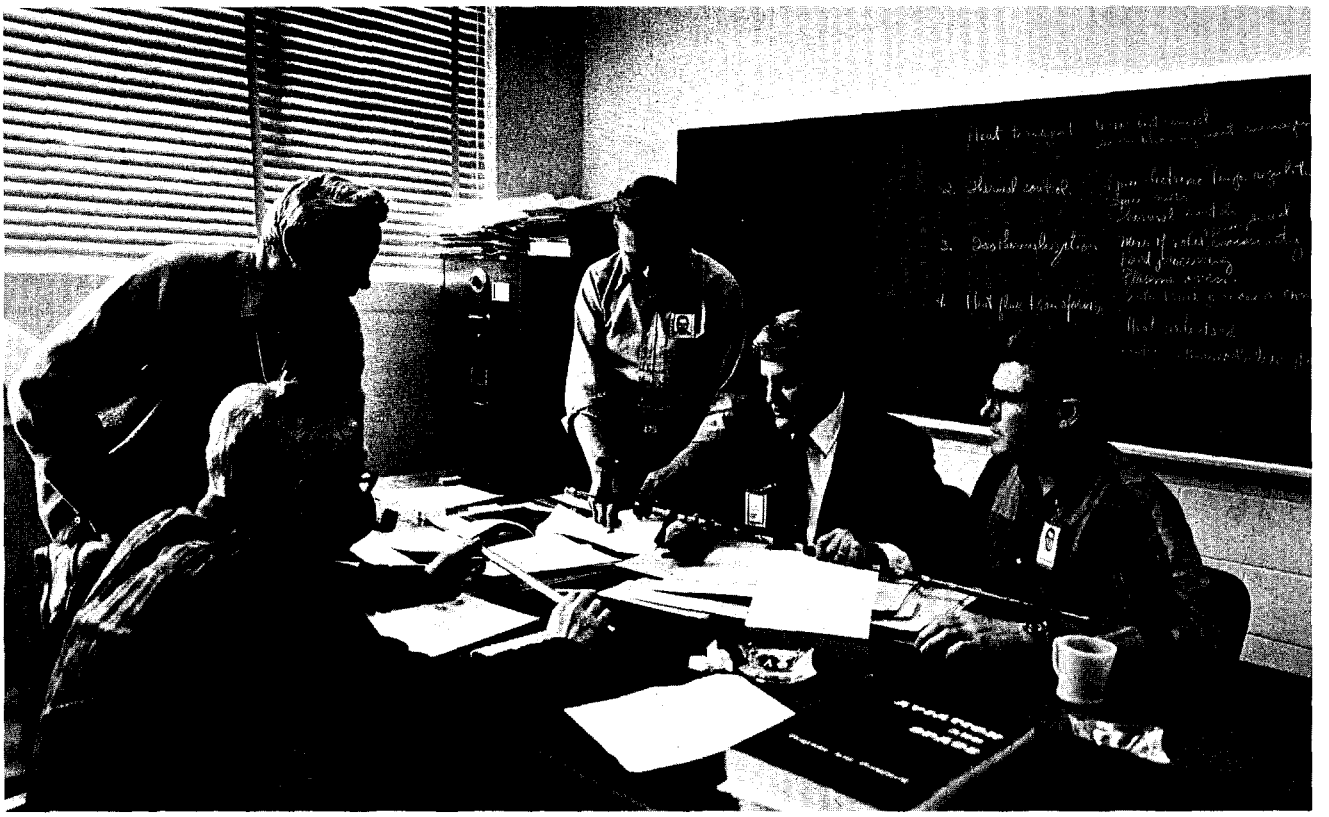


Snyder is shown a sampling of heat pipes by members of N-5. In foreground is John Deverall. Others from left are Walter Reichelt, Ernest Salmi, alternate group leader, Snyder and Ted Cotter.

D-6 opened the door for me to interview people and do the job effectively for the Laboratory.

"The problem in identifying usable technology is in getting people to know what we're interested in so that we can bring it to the surface. The things we accept must be new technology. They must meet three criteria: (1) they must be innovative; (2) they must not be trifling; (3) they must have potential significance to the nation's economy. Many projects are still classified, but often we can cull unclassified items from them.

"What we find will be released to the public in what we call AEC-NASA Tech Briefs. These briefs will be distributed to about 3,000 addressees including industry, universities, other government agencies and trade journals.

"Working with LASL, we will first write the briefs and send them back to the Laboratory for review by the innovators. Next, they will be cleared through LASL's patent office and read for technical accuracy by D-6. Then they are returned to my office where they will be revised, if necessary, and then printed and distributed by NASA. We're talking of about three months from first disclosure before distribution is made to the public.

"Each person named on the Tech Briefs as an innovator becomes eligible for a $25 award.

"If, later on, through our follow-up survey, we obtain enough convincing evidence that an innovation has saved major amounts of money somewhere or has resulted in new industry or processes, or if it has had some other significant impact, we reopen the award folder. When we have established the innovation's net worth, higher awards can be made ranging from $250 to $100,000. An award of this type is divided among the innovators listed in the Tech Brief.

"A follow-up survey is conducted about six months after distribution, on a random selection basis. The Denver Research Institute, under a NASA contract, sends out the survey forms. If an inquirer returns the form, we can have an

idea of the usefulness of the data we've provided to him."

When Snyder left Los Alamos, he had more than 150 spin-off items from Project Rover. "Most of these were surfaced by D-6 and L.D.P. King (research advisor to the Director's office and former Rover flight safety officer) prior to my coming here. They include such things as fabrication techniques, computer programs, measurement techniques, graphite and basic materials technology, computation methods, mechanical and electrical apparatus, and many others. I'm sure there are at least 200 to 300 more things to come out of this program. I plan to visit the Laboratory about twice a year to find them."

The Tech Briefs that are now being prepared for distribution to the public not only list the items that have potential uses, but also offer suggestions of how they might be used. The examples are numerous and highly diversified.

"The Rover people," Snyder said, "have compiled a very useful document dealing with the handling of hydrogen. This is something that industry has probably always wished was in writing, since it deals with what happens when you release a very large volume of hydrogen in air and explode it.

"Another document that will get great play is 'Handling and Use of Cryogens,' and another is the 'Theory and Design Fundamentals of Heat Pipes.'

"Rover scientists have also invented a very low cost cryostat—a dewar without a vacuum shell. There are many situations where someone might want to store a cryogen for, say, a week. Until now, he has been forced to use a dewar or a cryostat that will keep things for up to three weeks, and this is costly. One of your fellows discovered an inexpensive method of making cryostats from wood, cardboard or paper, and commercial insulating foils and foam. The cost was dropped from $150 down to about $10 for a 50-liter cryostat. These cryostats can be made 'one-shot' or reusable. They could become commercial products—perhaps even sold as kits.

"LASL has developed and put in use a very large heat exchanger at Jackass Flat. It converts a large volume of liquid hydrogen to gaseous hydrogen at an incredible speed, using water as a heat source. It transforms 50 pounds of liquid to gas in one second. The major innovation here is that this conversion is done by placing warm water adjacent to liquid hydrogen separated by a wall. The water heats the liquid hydrogen without ending up as ice. The trick is in preheating the water with a small propane unit, storing it in a tank, and pumping it past the hydrogen at a high speed.

"The heat exchanger has a reasonably high commercial potential. Natural gas is the primary home fuel in most cities and gas storage can be a problem. For this reason it is advantageous to compress the gas to its liquid form. This is all right as long as you know the rate at which the gas is to be delivered to the customers and you can meet surge demands. For peak loads, however, such as when housewives start to cook dinner, a heat exchanger like this one could be used for quick conversion from liquid to gaseous form.

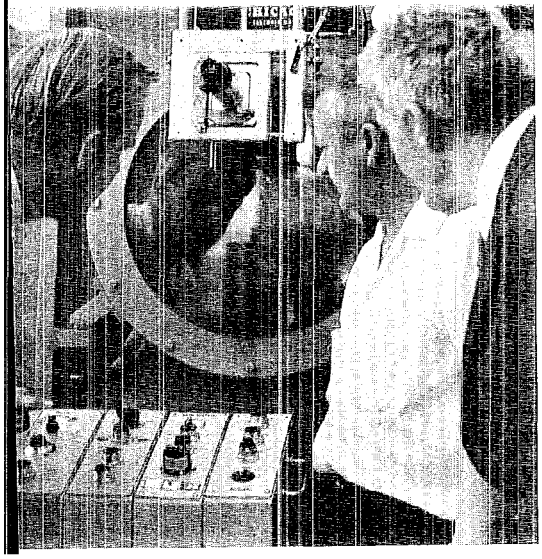
"Other important discoveries have been made in the area of brittle materials such as graphite and carbon-carbide composites. When you bunch graphite and these composites together, you're looking at more than 50 per cent of the known brittle materials. These things are most difficult to examine in thermal stress fracture; when you warm a material slowly, how does it break? They're also difficult to examine in thermal shock fracture—fast heating. The problem was to find a simple way of grading materials in terms of stress and shock behavior and to do it in a reliable manner. If there are, say, 10 different forms of graphite, which has the least resistance to stress fracture and which has the most? And, if you repeat the process of examination, can you get the same answer each time? The scientists here have developed simple equipment for examining stress and shock fractures. This represents a major breakthrough. They have developed reliability in results. In taking a measure in thermal shock, the equipment is so simple that an above-grade high school student could be trained to operate it in two hours.

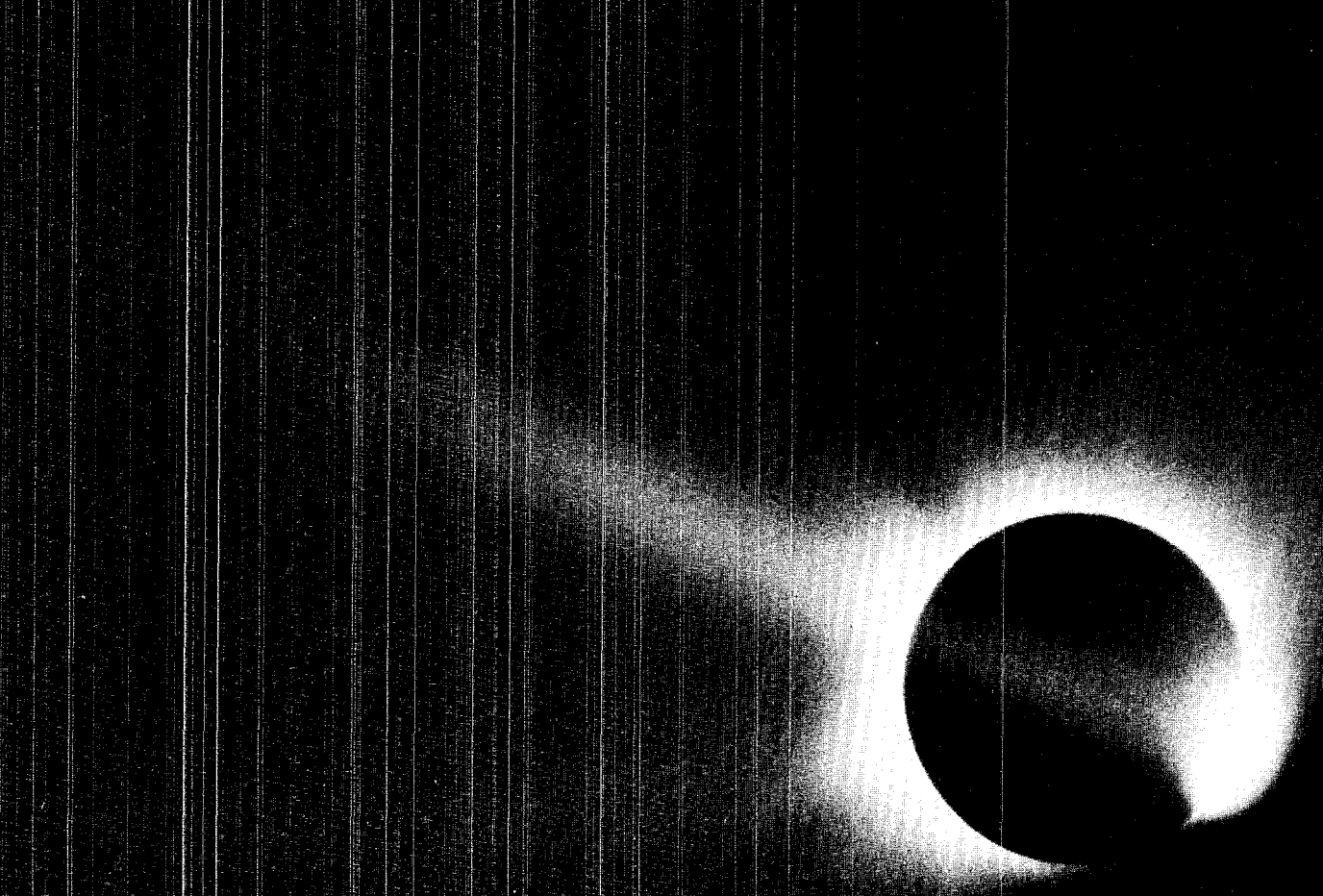
"The impact here is that test laboratories in general, and those in which people work on such things as turbine blades and high speed aircraft, will have a piece of equipment on which they can rely.

"Another good item that has come out of the Rover program is the heat pipe, which is designed to remove heat from an unwanted area and dissipate it elsewhere."

These are but a few of the examples, pointed out by Snyder, of technology developed at the Los Alamos Scientific Laboratory for Project Rover—good examples of how basic research serves as the stepping stone to practical applications.

Don Sandstrom, CMB-6, and Hanks demonstrate innovations made on an electron beam welder to Snyder. Two of the major innovations are an optical viewing system (the lense apparatus near the top of the window), and a beam diameter measuring device which is not visible externally.





"SECOND CONTACT . . . NOW."

As these words signifying totality came over the intercom aboard Air Force 369, night came before noon and physicists from the Los Alamos Scientific Laboratory made a long-planned rendezvous with the solar eclipse of March 7.

The sun blacked out at 17 hours 37 minutes and 55.5 seconds Universal Time at a point nearly seven miles above the Gulf of Mexico. For exactly 330 seconds the men of LASL bent over their various instruments and ran carefully prepared data gathering programs. The flying laboratory chased the speeding eclipse of darkness at 585 mph, but all too soon the jet was outdistanced by the 1,500 mph shadow and day returned.

To the east and north, hundreds of scientific colleagues and millions of other Americans waited for the so-called "eclipse of the century" to first touch the United States between Apalachicola and Cross City, Florida, and then darken the eastern seaboard from Georgia to Monomoy Point in Massachusetts. To the west of the airborne LASL experimenters, ground-based scientists had already taken their data along a narrow path of totality which crossed the Isthmus of Tehuantepec in Mexico. And even further to the west over the Pacific Ocean, another group of flying solar investigators from the Air Force Cambridge Research Laboratory had been first to encounter totality. For more than two and a half hours prior to intercept, the LASL/AEC NC-135 jet flew a race track orbit pattern which just skirted the Mexican coast south of Vera Cruz between Chorrera and Minatitlan. The orbit patterns, each of 16 minutes duration, allowed Major Ed Carr, senior navigator, and Major Billy Buttram, pilot and aircraft commander, to refine the carefully plotted course, allowing for wind and other navigational factors, in order to provide optimum aircraft performance and placement for maximum observation time.

Night Before Noon

Photos and Story by Bill Regan

When Major Buttram straightened the plane on its final heading two minutes ahead of second contact he could see the eclipse shadow rushing across the sea behind and was heard to say: "It's like a big black wall moving across the ocean." Major Carr who saw the shadow only as it outdistanced the plane at the end of totality (third contact) likened it to "looking at a big, blue funnel running away from you."

When that big black wall engulfed the aircraft, LASL Scientific Coordinator Art Cox, J-15, calculated that interception of the speeding spot in time and space occurred with an error of only one second, a remarkable feat of navigation. With this kind of navigation the observers should have had 338 seconds of totality, but lost eight seconds because of some unexplained anomaly in calculations of the eclipse path.

As the sun's once blinding disc was nibbled down to a thin crescent, the sky seen through the aircraft windows changed to darker and darker shades of blue and finally became that blue-purple shade that is almost black. The light from the final crescent had an eerie, pale quality similar to the apparently bright but actually dim illumination provided by aerial flares at a fireworks display finale. About 40 miles off to the side where the shadow's edge lay, those few eyes not fixed on scientific experiments could see the rosy glow of pseudo sunrise or sunset. The last rays of the eclipsed sun flashed through the jagged topography of the moon's edge and the beautiful light-show called Bailey's Beads appeared as a string of shining jewels.

Just prior to totality the halo of the sun's corona could be seen dimly through the fading glare. Then totality occurred with the magenta rim of the chromosphere first appearing fleetingly and broken by a bright red prominence on the upper right edge of the sun's now blacked out disc. And almost immediately, the corona—a spreading pearly-white glowing plasma of highly-ionized gases (primarily hydrogen but with some helium and traces of heavier ions) appeared in all its full beauty. Now it became obvious that this was an active sun, at the high point of its 11-year energy cycle, for spurting out in all directions for millions of miles were bright streamers glowing more intensely than the corona itself.

This corona and its streamers were the focus of all the activity of four LASL scientific teams whose many months of planning and training culminated in these few precious minutes of data gathering. A fifth team of LASL and Sandia Laboratories experimenters attended to a nearer subject—the earth's upper atmosphere airglow and the effects upon it of a sudden, untimely darkness.

From near corona to its most distant reaches, LASL scientists probed with telescopes, spectrometers and interferometers in a continuing investigation into temperatures and abundances of various

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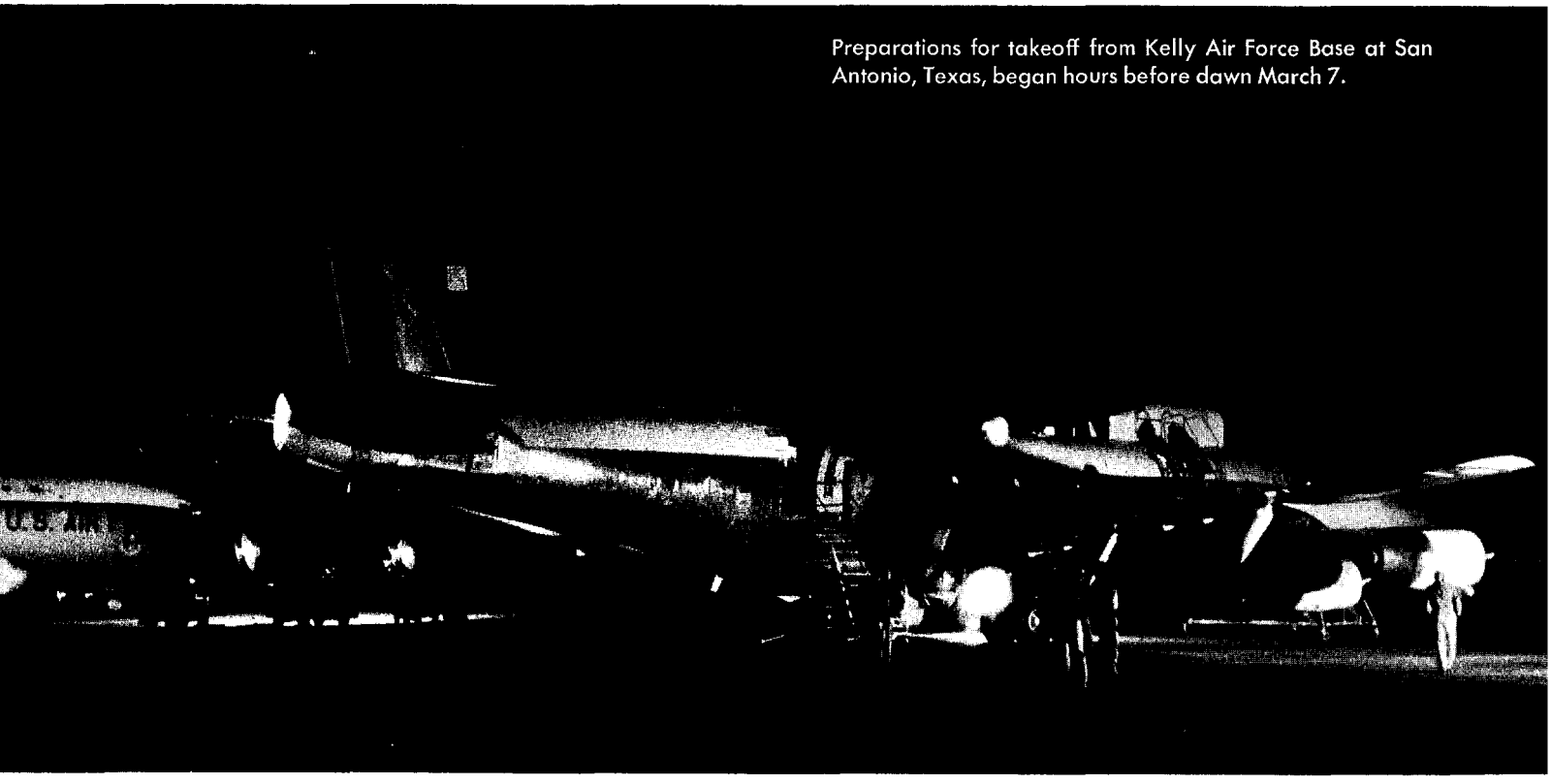

Preparations for takeoff from Kelly Air Force Base at San Antonio, Texas, began hours before dawn March 7.

ions in this most interesting hot but low density plasma. White light and selected wavelengths thereof, plus the infrared end of the spectrum produced records on film, data tape and video tape for long and detailed later study and analysis in the laboratories of Los Alamos.

If an observer could have picked his way through the narrow aisles of the experimental areas jammed with scientific team members he would have seen the following:

Immediately aft of the pilots' and navigators' compartment in the nose, John Hafer, N-4, electrical engineer, brooded over two electronics panels controlling gyro stabilized platforms for documentary movie and still cameras. Having already corrected a burned out circuit in flight Hafer was alert to any further malfunctions.

Hemming Hafer in on the window side of the aircraft was the large console, containing data recording equipment for the infrared spectrometer experiment, which measured emissions of the near corona in the infrared end of the spectrum. On the floor at his feet were infrared experimenters Ken Olsen and Chuck Anderson, both J-15, assisted by Geoffrey Watts,N-4, all busy with various buttons, dials and control widgets for the tracking mirror, 12-inch Cassegrain telescope and nitrogen-cooled detectors. Cabin temperature was lowered to 45 degrees to improve performance of instruments in this experiment.

Standing next to experimenters sprawled on the floor was Bob Harper, D-10, documentary movie photographer, with right eye pressed to 16 mm camera finder and hands controlling stabilized platform. Next upper window was filled with two still cameras, a 500 mm lens Hasselblad and a Nikon with a 600 mm lens, operated by Bill Regan, PUB-1.

Astronomer Bob Brownlee, J-DO, elbowed for space next to the PUB station and watched both eclipse and the experimenters on his right who were making the same observations of far out corona and streamers that he had made during the 1966 eclipse. Press of other responsibilities prevented Brownlee from serving as the scientific coordinator for the 1970 eclipse mission.

Crammed into the small area at Brownlee's right were the 25-inch focal length coronal camera with necessary mechanical and electrical equipment plus Astronomer Chick Keller, J-15, and his smoothly-functioning team of Bobby Strait, C-8, electrical engineer, Bud Winslow, GMX-8, senior optical specialist, and Larry Rice, J-7, mechanical engineer.

In the command area Scientific Coordinator Cox peered at a sun compass image on a chart, made rapid calculations on predicted totality duration from time of second contact, talked on the intercom to navigator and pilot, and listened for any scientific problems on the various communication nets. On his left, Jim Wells, J-1, a veteran of two previous eclipse missions as former pilot-commander of Air Force 369, described totality and aircraft activities on a high frequency radio broadcast to a press center in Albuquerque. There Max Garcia and George Morin, both of EG&G, handled communications — radio

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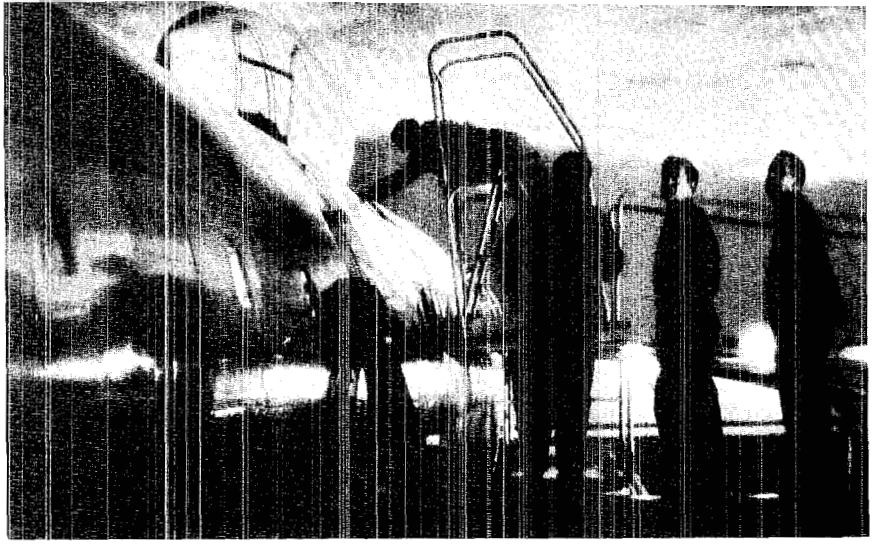
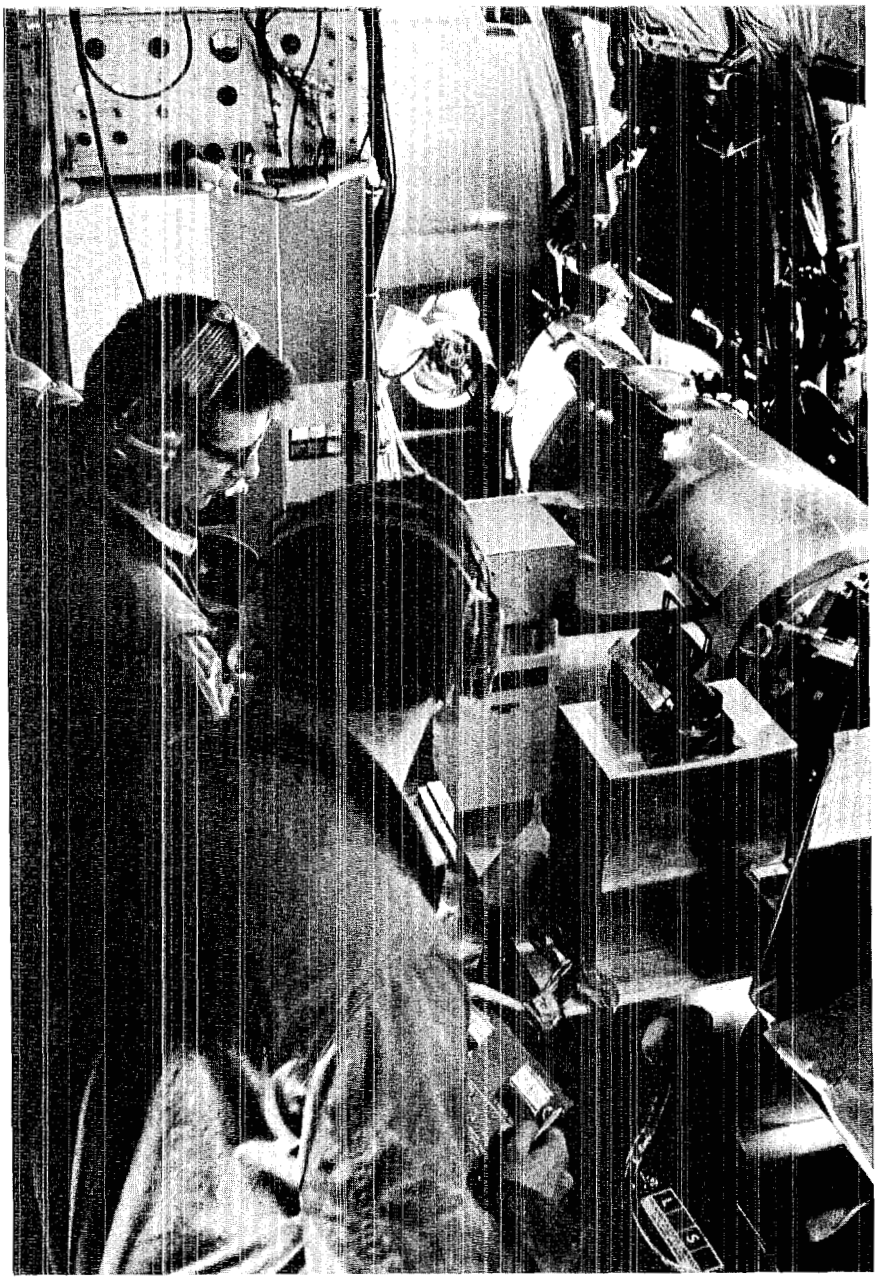
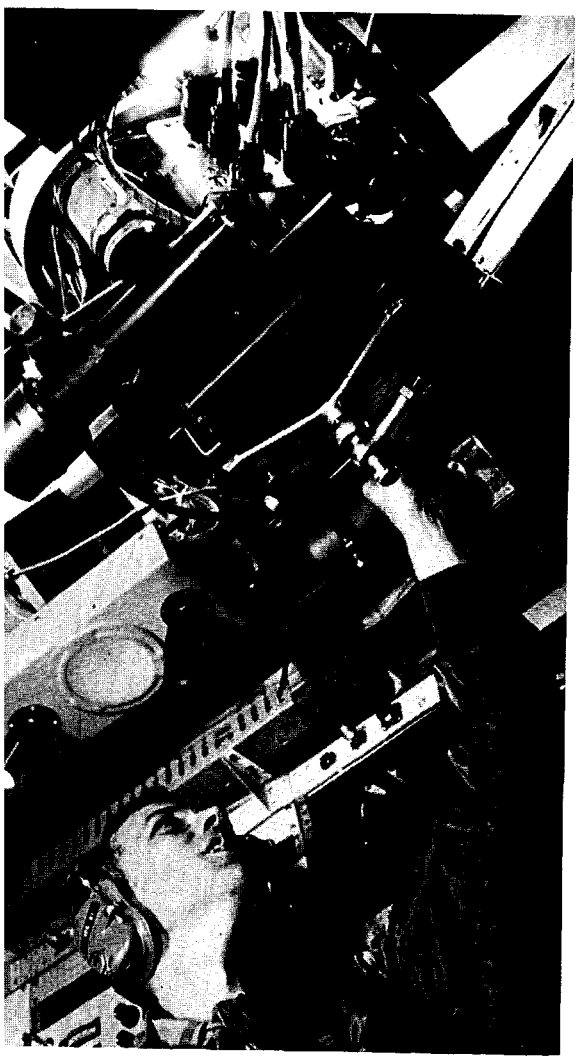


As dawn streaked the sky, Bud Winslow, GMX-8, on ladder, cleaned the observation window for the coronal camera experiment.

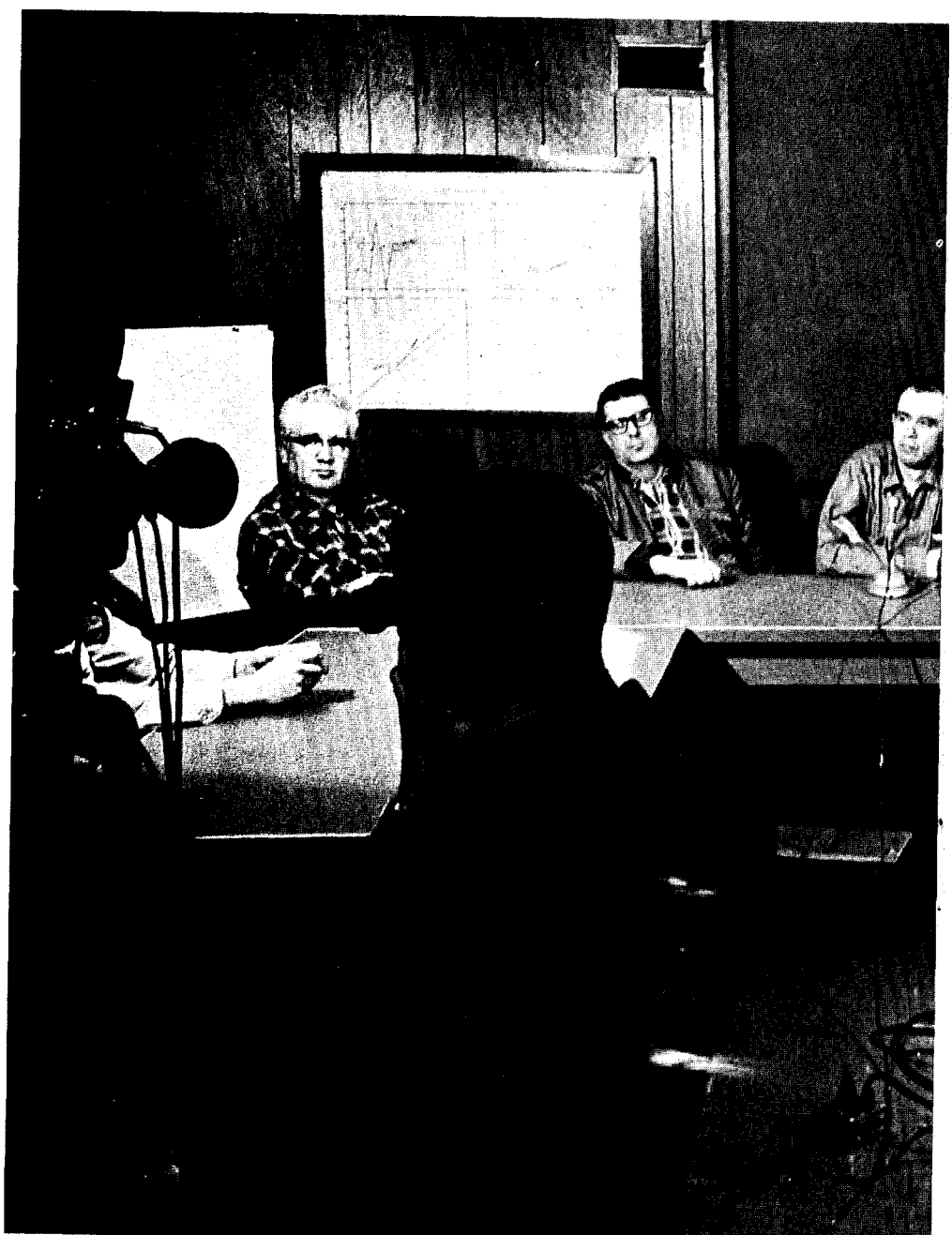


Ken Olsen and Chuck Anderson, both of J-15, calibrate the infrared spectrometer.

Right, UPI Science Reporter Ed DeLong, right, listens to Scientific Coordinator Art Cox outline experimental goals. At left is Chick Keller, J-15.



Above, Rolf Engleman, GMX-2, inserts a film holder in the nine-lens emission line camera.



Right, San Antonio news media people interviewed the scientists from New Mexico en masse on eclipse day. From left are: Mert Robertson, Sandia Laboratories, Olsen, Cox, Major Billy Buttram, aircraft commander, Keller, and Engleman.

code name KIVA—while Bill Richmond, PUB-1, and Sid Stone, J-10, answered questions from news media reporters.

To Cox's right was Tom Gilliam, EG&G radioman, who gave the official countdown and timing signals. In back of Gilliam, Gordon Worthem, Sandia Laboratories, recorded inertial navigation system data. In the next work bay behind the command area, Rol Hewett, Sandia Laboratories, supervised the dual tape recording system which preserved comments and scientific data on eight channels.

About half-way aft in another crowded work bay, John Wolcott, J-16 physicist, and Mert Robertson, Sandia collaborator, kept close watch on a photometer that registered data on effects of the sudden blackout of light on the earth's airglow, an excitation process caused by charged particles from space hitting the upper atmosphere.

Crowded against the right wall and making like contortionists in their efforts to see the eclipse through narrow passenger windows were Tom O'Toole, Washington Post science writer, and Ed DeLong, UPI science and space reporter.

A few more steps aft and our fictitious strolling observer would have been halted by an almost solid wall of experimenters—that is if he had not already been blocked by big

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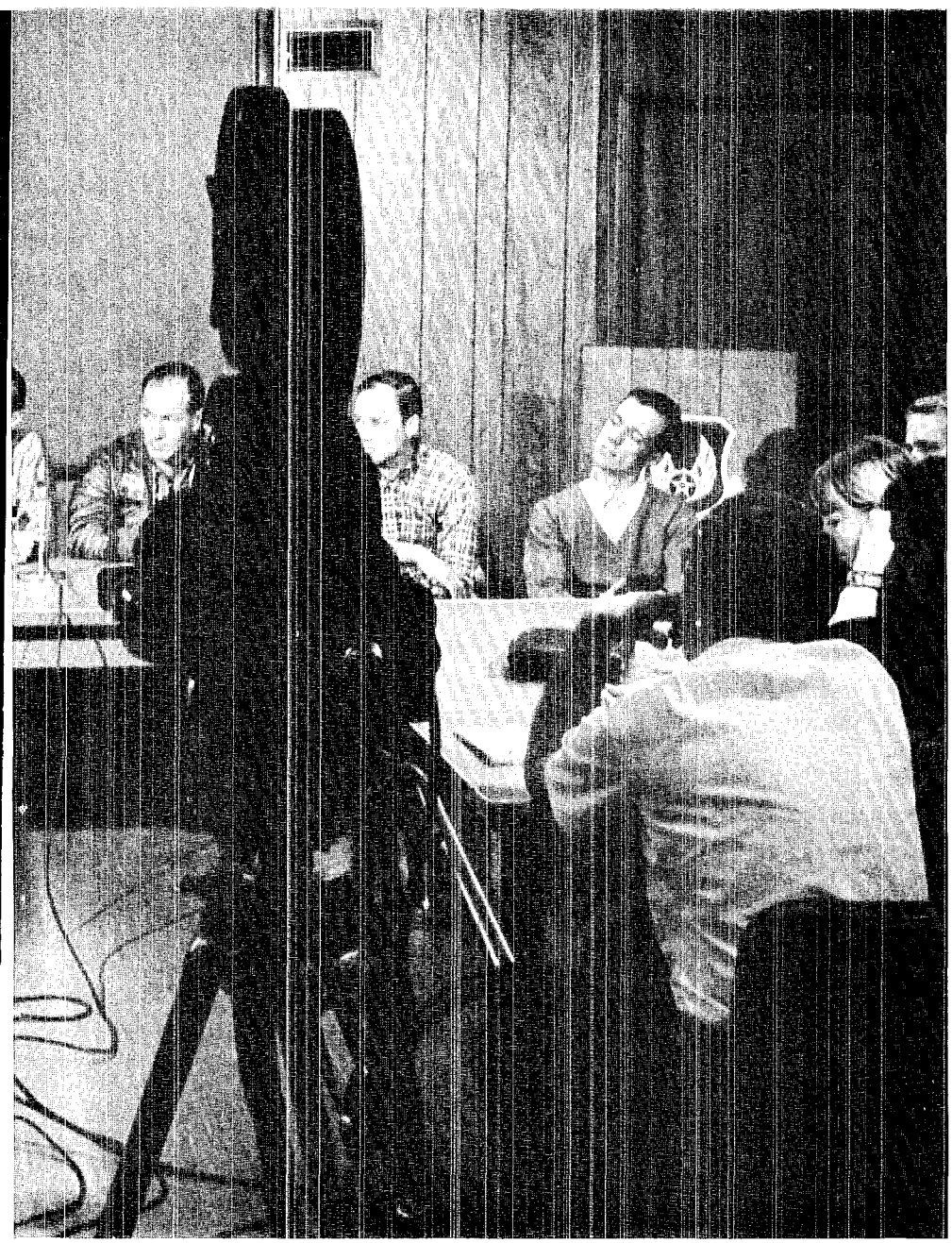
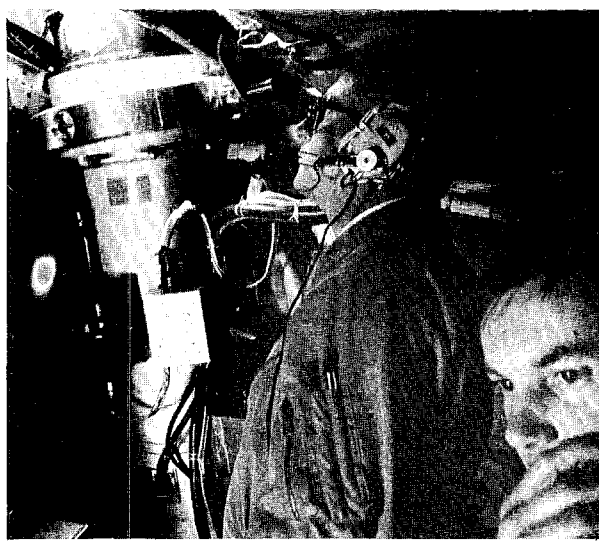
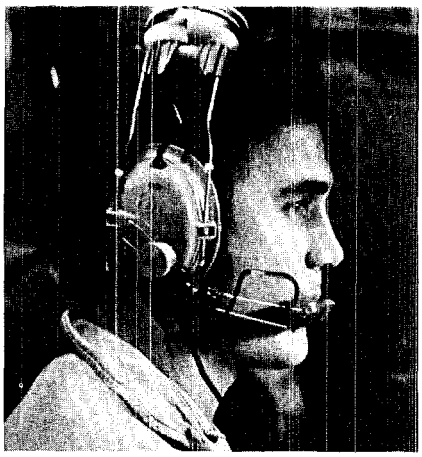
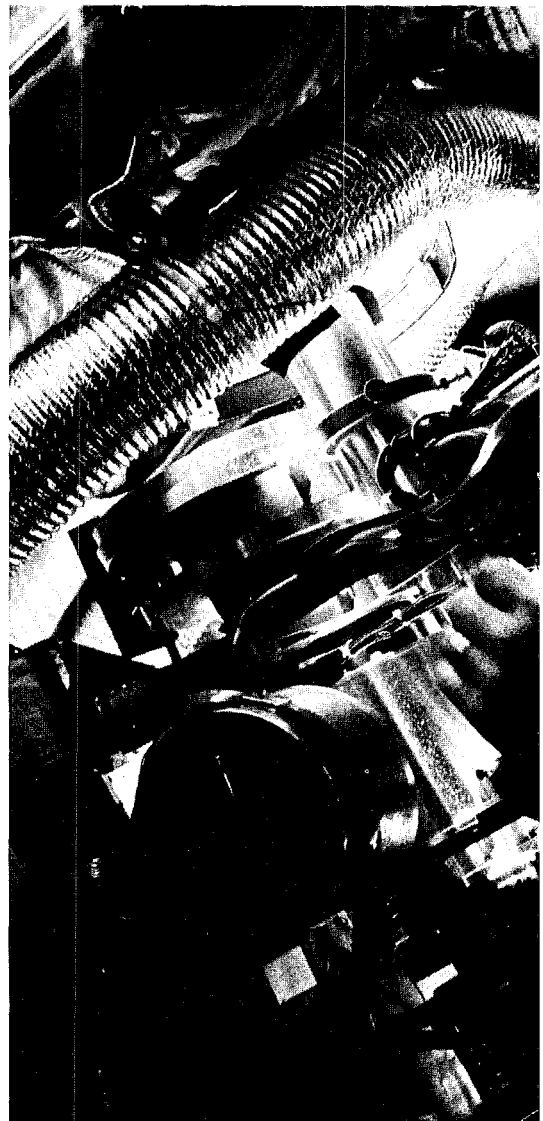




Above, the sun's image appears on the video screen at left as Rube Goldberg experimenters Bob Lang, J-8, and Don Liebenberg, right, CMF-9, talk over tracking problems on intercom.



Upper left, Geoffrey Watts, N-4, records data. Left, John Wolcott, J-16, keeps his eyes on recording graph for the airglow experiment. Lower left, Bobby Strait, C-8 concentrates on readings from electronic equipment. Above, Major Ed Carr, senior navigator, consults with Jim Wells, J-1. Right, Bob Brownlee, J-DO, left, watches coronal camera team in action. Team leader Keller is flanked by Winslow, partially hidden, and Strait, in foreground.

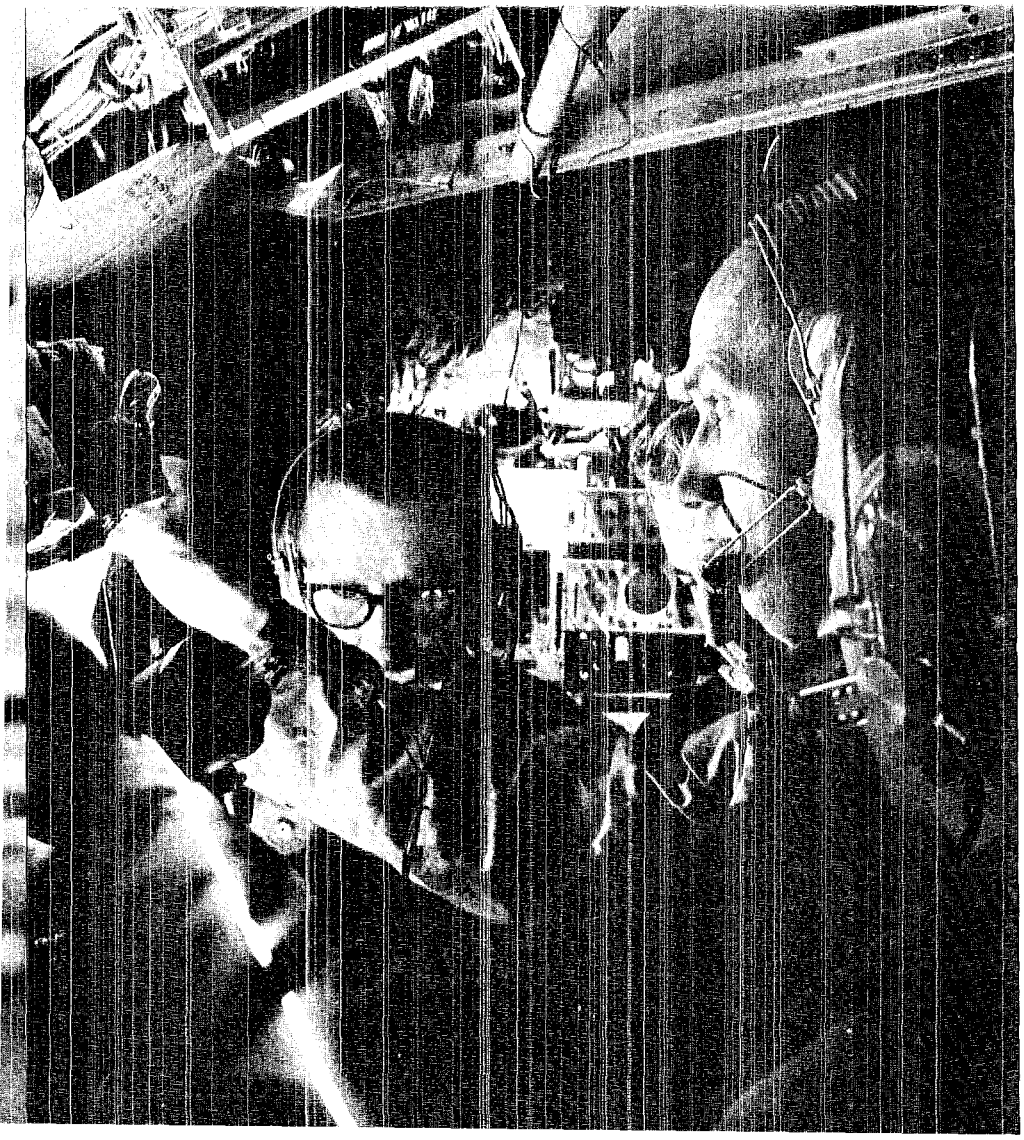


Wayne Adams, General Dynamics engineer, who moved around checking special electrical and air conditioning equipment, window defoggers, and a multitude of other details vital to scientific data gathering. For here, far in the rear of the aircraft was the Rube Goldberg 80-inch telescope which scanned the corona through a Fabry-Perot interferometer and recorded in great detail abundances of Fe XIV and Fe X (respectively the green and red emission lines of iron). This largest and heaviest experiment in the aircraft was presided over by Marv Hoffman, J-12, who directed a team consisting of Bob Lang, J-8, Ed Brown, N-4, Joe Calligan and George Yates, both J-12, and Don Liebenberg, CMF-9, a veteran eclipse observer who had been the major domo of the Rube on the 1965 and 1966 solar eclipses. The instrument was modified for the 1970 effort with an image orthicon video system for recording data.

"THIRD CONTACT. . .THIRD CONTACT"

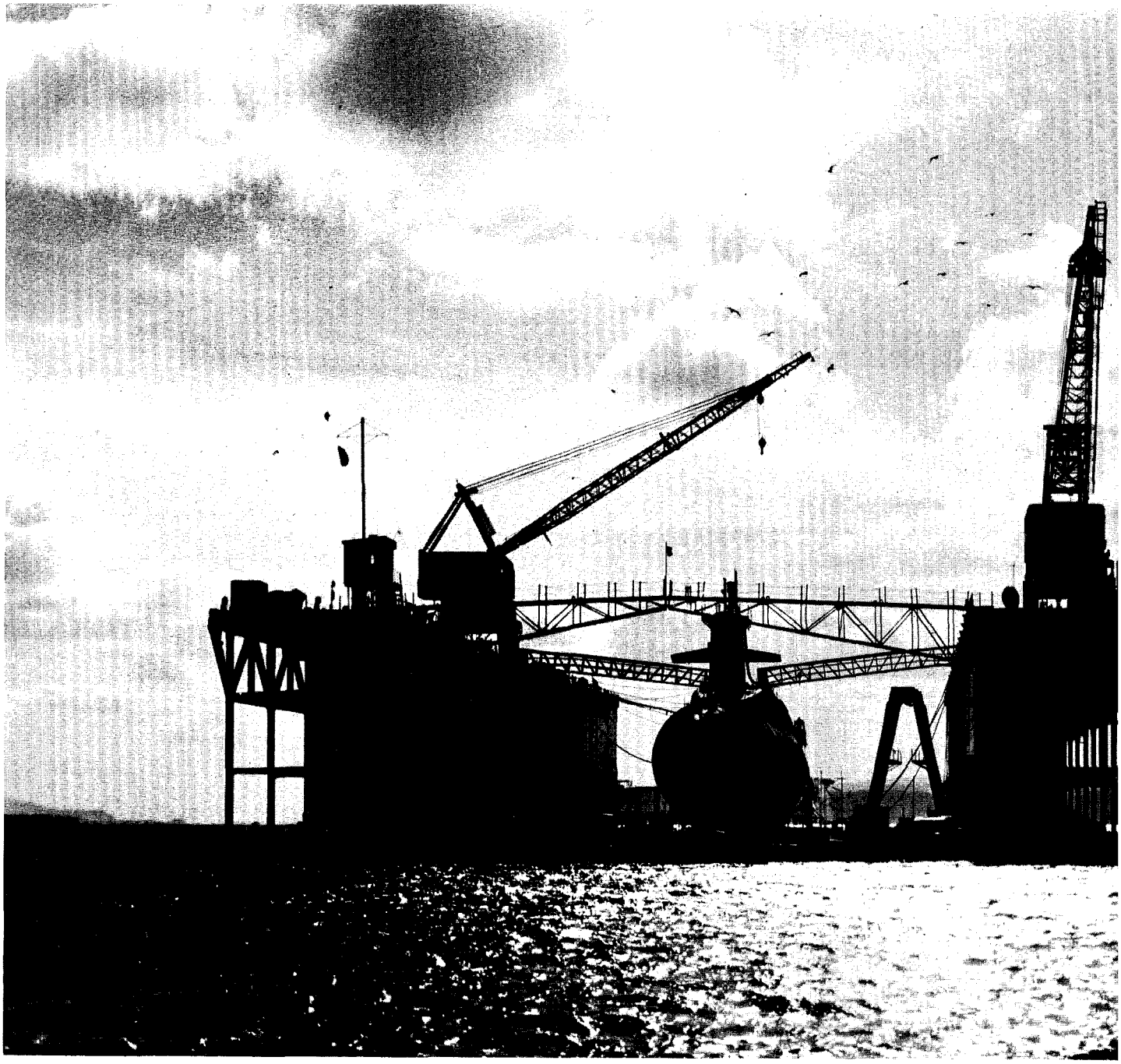
The official announcement of the end of totality came over the intercom along with several excited voices of observers who spotted the flash of the sun's reappearance from behind the moon. The work of data gathering was over except for a few minutes of calibration exposures. Tension eased and once again normal conversation could be heard on the communication nets. Experimenters queried each other about how things had gone with the various modes of solar investigation. The consensus was, "very well." There were the usual number of small disappointments, but no major failures of equipment. And just how good the data are, only long analysis continuing for many months will tell.

Newspapers describing the eclipse and LASL's role in observing it were prime reading material on the return flight to Albuquerque. Even Cox, who had a good view of the eclipse, read all about it.

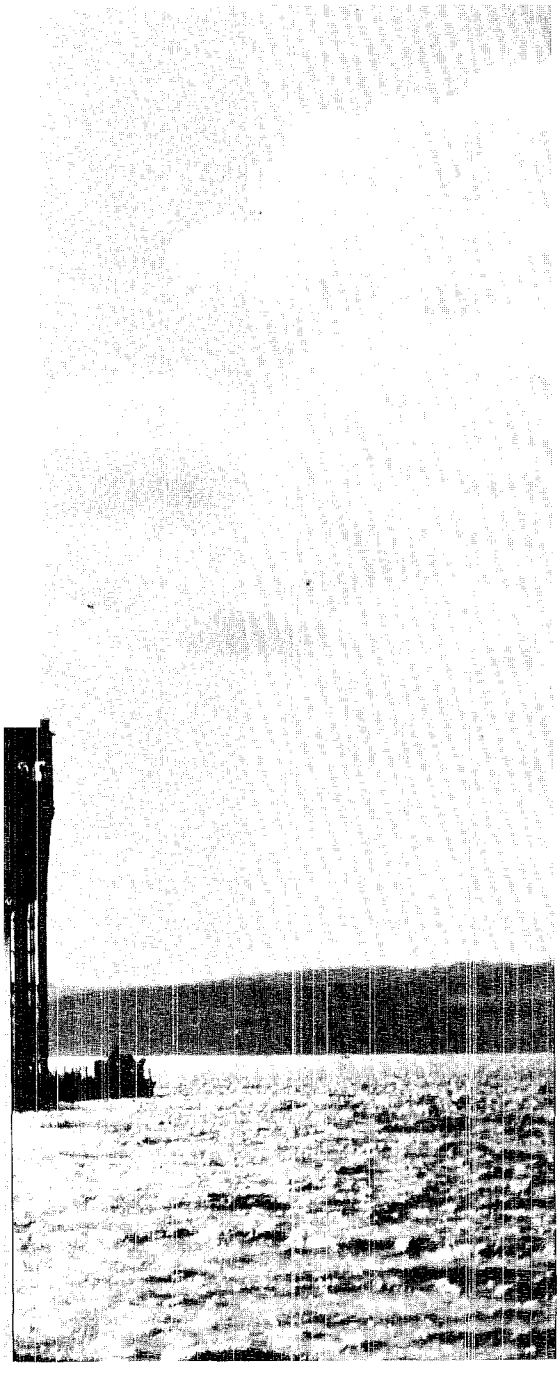


Marv Hoffman, J-12, team leader for the Rube Goldberg, talks to his crew on the intercom.

The Good



Ship Los Alamos



Late in 1961, the nuclear submarine George Washington pulled into Los Alamos. Since then Los Alamos has hosted many nuclear submarines.

Sound weird? Maybe, but it's true.

Los Alamos, in this case, however, is a U.S. Navy floating drydock named after the town in northern New Mexico.

The U.S. Navy operates many floating drydocks to supplement drydock facilities at major naval activities, to support fleet ballistic missile submarines at advanced bases, and to provide repair capabilities in forward combat areas such as South Vietnam.

In all there are 84 U.S. Navy floating drydocks. Twenty-nine are in service; 18 are in reserve; 32 are on lease to commercial firms for private use; and 15 are on loan to other U.S. services or to foreign navies.

All of them were built during World War II with the exception of one which was built in 1934. Berthing facilities, repair shops, and machinery are housed in the sides of the docks. The larger ones, such as the Los Alamos, were made sectional to facilitate movement overseas. None of them are self-propelled.

The submarine Abraham Lincoln is shown docked at the USS Los Alamos at Holy Loch, Scotland. (U.S. Navy Photograph)

The seven sections of the Los Alamos were built in 1944 and 1945. They were towed to the Mare Island Navy Yard and put into operation in March of 1945. The following year they were placed on the inactive list.

In August of 1946, the floating drydock was disassembled and towed to the east coast where it entered service with the Atlantic Reserve Fleet at Green Cove Springs, Fla., in January of 1947.

Early in 1961, four of its sections were towed across the Atlantic Ocean to Holy Loch, Scotland, where the Navy established an important base for fleet ballistic submarines. They were converted into a drydock for submarines and dubbed the Los Alamos. The four sections weigh a total of 40,000 tons. Each has a lifting capability of about 10,000 tons.

The floating drydock's first patron was the George Washington in November of 1961. Since then it has continued to serve submarines of the "Highland Squadron" at Holy Loch.

Another section of the Los Alamos is being used at Kwajalein Atoll by the U.S. Army in support of a Nike-X missile project, and the remaining two sections are being held in reserve.

short subjects

Congressman Manuel Lujan, Jr., takes a spin on one of several bicycles used for quick transportation in the accelerator tunnel at the Los Alamos Meson Physics Facility which is under construction. A tour of LAMPF was included in activities planned for his one-day visit to Los Alamos. At right is Darragh Nagle, alternate MP division leader and MP-4 group leader.

Of 69 patents recently made available to the public by the Atomic Energy Commission, five pertain to inventions of employees of the Los Alamos Scientific Laboratory.

They are: "Method of Changing Gloves in a Controlled Environment Box" by **J. W. Woolsey,** K-3; "High Pressure Preparation of Yttrium Sesquicarbide" by **M. C. Krupa, A. L. Giorgi, N. H. Krikorian** and **E. G. Szklarz,** all of CMB-3; "3-Picrylamino-1, 2, 4-Triazole and Its Preparation" by **M. D. Coburn,** GMX-2; "Particle Separator" by **H. P. Deinken,** W-9, **D. L. Bell,** SD-5, **J. A. Zastrow,** MP-2, and **J. Hill,** a former LASL employee with SD-5; "Method of Preventing Plutonium Leakage" by **C. Wohlberg,** a former LASL employee with K-2.

Family Days, scheduled for June 27-28 at the Los Alamos Scientific Laboratory, have been cancelled it was announced by **Director Norris Bradbury.**

"I think it would be financially unwise this year," Bradbury said, "to spend the money which would necessarily have to be allocated for Family Days. A considerable amount of overtime, shop orders, printing, transportation costs, and loss of productive time on research programs are involved, and I'm afraid we are going to be right up against our spending limitations. I have made this decision reluctantly and regretfully, because Family Days have always been enjoyable and well received in the community. However, a lot of worthwhile things are having to be postponed and a lot of people are having to make much more serious personal sacrifices than this because of the financial difficulties in which the Laboratory finds itself. I hope at some future time we can again plan to have a Family Days observance."

In spite of the cancellation a veteran's reunion planned in conjunction with Family Days will be held. This reunion will be held June 26-28 for all persons who were in uniform at Los Alamos during the war years. Approximately 1,000 veterans have already registered for the event and officials expect attendance to be between 1,500 and 2,000.

Three Laboratory employees died during March.

Ralph H. Perkins, K-2 group leader, died March 2. He is survived by his wife, Marion, and two daughters, Sherrie Lynn and Nancy Jo. Services were held in the Church of Jesus Christ of Latter-Day Saints in Los Alamos. Interment was in Guaje Pines Cemetery.

Pablo Sisneros, GMX-6 firing site leader, died March 7. He is survived by his wife, Mary Lillian, and two daughters, Pauline and Neville. Services were held in the Santa Clara Catholic Church. Interment was in Santa Clara Cemetery.

Leopoldo Ortiz, animal caretaker for H-4, died March 11. Funeral services were held at Sacred Heart Church of Nambe and burial was in Sacred Heart Cemetery. Ortiz had been an animal caretaker at the Laboratory since 1946—until 1954 as an employee of Zia Company, and since then as an H-4 employee. He is survived by his wife, Elena; three daughters, Darlena, Syvilia and Pamela; and two sons, Ramon and Waldo.

the technical side

Presentation to Temperature Standard Section of the National Bureau of Standards, Gaithersburg, Md., Jan. 2:

"Mossbauer Effect Thermometry" by R. D. Taylor, CMF-9 (invited)

Presentation at Inter-agency Mechanical Operations Group Joining Sub-group Meeting at G. E.-Pinellas Neutron Devices Department, St. Petersburg, Fla., Jan. 20-22:

"Mechanical Properties of Electron Beam Weldments of High Strength Steels" by D. J. Standstrom and G. S. Hanks, both CMB-6

Presentation at St. Michael's High School, Santa Fe, Feb. 2:

"Cryogenics and Cryogenic Engineering" by F. Edeskuty, CMF-9 (invited)

Presentation at the Sandia Corporation Material Science Seminar, Albuquerque, Feb. 4:

"Plastic Deformation Under Multiaxial States of Stress" by S. S. Hecker, CMF-5 (invited)

Presentation at the University of Chicago, Ill., Feb. 4:

"Vela Satellite Observation of Cosmic X-Ray Sources" by W. D. Evans and J. P. Conner, both P-4 (invited)

***Presentation to graduate students* of Nuclear Engineering at Kansas State University, Manhattan, Feb. 4:**

"Nondestructive Testing and Evaluation—A Challenge to the Institutions of Higher Learning" by G. H. Tenney, Dir. Off. (invited)

Presentation at Department of Physics, University of New Mexico, Albuquerque, Feb. 6:

"Soft Pion Production in NN Collisions" by R. R. Silbar, T-9

Presentation at Kiwanis Luncheon, Los Alamos, Feb. 9:

"Geology of Jemez Mountains" by W. D. Purtymun, H-6

Presentation at seminar of the chemistry department of Michigan Technological University, Houghton, Feb. 9:

"Determination and Importance of Oxygen-to-Metal Atom Ratio in Mixed Oxide Reactor Fuels" by G. R. Waterbury and C. F. Metz, both CMB-1 (invited)

Presentation at the Atomic Energy Institute, Kurchatov, Russia, Feb. 13:

"Heat Pipes" by G. M. Grover, N-5 (invited)

Presentation to staff of Sacramento Peak Solar Observatory, Sunspot, Feb. 13:

"A Model for Formation of Solar Systems from Massive Supernova Fragments" by W. K. Brown, P-3

Presentation at International Atomic Energy Agency Symposium on the Handling of Nuclear Information, Vienna, Austria, Feb. 18:

"The Network Concept of AEC Libraries and Their New Joint Book Acquisitions System" by Helen F. Redman, D-2

Presentation at Rotary luncheon, Los Alamos, Feb. 18:

"Geology of Pajarito Plateau" by W. D. Purtymun, H-6

Presentation at the 26th Meeting of the Inter-agency Mechanical Operations Group Sub-group on Gauging, Sandia Laboratories, Albuquerque, Feb. 18-19:

"Nondestructive Method for Measuring Cross Sections of Small Objects" by B. A. Pentecost, GMX-3

Presentation at luncheon of the Rio Grande Chapter of the Health Physics Society, Los Alamos, Feb. 19:

"Environmental Monitoring of Surface and Groundwater" by W. D. Purtymun, H-6

Presentation at AEC Graphite Coordination Working Group Meeting, AEC Headquarters, Germantown, Md., Feb. 19:

"Carbon and Graphite Research at LASL" by M. C. Smith, CMF-13

Presentation at the American Chemical Society Spring Meeting, Houston, Texas, Feb. 22-27:

"Oxygen-17 NMR Studies of Uranium Oxides" by H. G. Hecht, W. B. Lewis, and M. P. Eastman, all CMF-2

"*Systematics in Properties and* Structures of Actinide Fluoride Complexes" by R. A. Penneman and R. R. Ryan, both CMF-4 (invited)

"The Acetylation of 3-Amino-1, 2, 4-Triazole" by M. D. Coburn, E. D. Loughran, and L. C. Smith, all GMX-2

"Kinetic Energy Distribution in the Spontaneous Fission of Fermium-257" by J. P. Balagna, G. P. Ford, Darleane C. Hoffman, and J. D. Knight, all J-11

Presentation at seminar at Pennsylvania State Medical School, Hershey, Feb. 24:

"Repair of Ultraviolet Light-Damaged DNA in Haemophilus Influenzae" by G. J. Kantor, H-4 (invited)

Presentation at the 14th Annual Meeting of the Biophysical Society, Baltimore, Md., Feb. 25-27:

"Cell Preparation Methods for Flow Microfluorometers" by P. F. Mullaney and T. T. Trujillo, both H-4

"DNA Distributions in Cell Populations by High-Speed Microfluorometry: Sources of Dispersion" by M. A. Van Dilla and T. T. Trujillo, both H-4

"Ultraviolet-Inactivation of Haemophilus Influenzae: A Composite Effect" by B. J. Barnhart and S. H. Cox, both H-4

"Electronic Cell Separation: Volume Distribution of Colony-Forming Stem Cells in Mouse Bone Marrow" by M. J. Fulwyler, H-4 and T. T. Puck and P. Wuthier, both of the University of Colorado Medical Center, Denver

"*Invariance* of Cell Density Around the Mitotic Cycle" by E. C. Anderson, D. F. Petersen and R. A. Tobey, all H-4

"Effects of X-Irradiation on the DNA Synthetic Period in Synchronized Mammalian Cells" by R. A. Walters and R. A. Tobey, both H-4

"Single-Strand DNA Breaks in a UV-Irradiated Mutant of Haemophilus Influenzae Incapable of Excising Thymine Dimers" by G. J. Kantor, H-4

"Accuracy of Growth Rate Determination by the Collins-Richmond Equation" by E. C. Anderson, H-4 and G. I. Bell, T-DOT

20 years ago in los alamos

Culled from the April, 1950, files of the Los Alamos News by Robert Porton

Film Being Made at Pueblo

One of the largest mass movements of important screen players and crew to this area occurred this week. Twentieth Century-Fox's "Trumpet to the Morn" company flew out from California in two chartered planes for 29 days of filming at nearby San Ildefonso Pueblo. In the multi-million dollar cargo were Cornell Wilde, Joseph Cotten and Jeff Chandler. Leading Lady Linda Darnell had arrived earlier. The film, dealing with little-known western phases of the Civil War, will be shot almost entirely in and around the adobe Indian village.

Security Division Reorganization Approved

In keeping with his announced policy of separating regional functions from local Los Alamos operations, C. L. Tyler, manager, Santa Fe Operations office, has approved reorganization plans for the AEC Security division. Heading the Inspection Branch in the newly established Office of Security is W. Tyler Aldrich, Jr. In charge of Personnel Security in the Los Alamos Branch is H. Jack Blackwell.

Flagstone Offered to the Public Without Charge

Flagstones for walks and patios will again be available locally without charge, the Town Planning Board announced. Frank Di Luzio, who owns mining rights to such stones at a location in Dell No. 1 on Sawyer Mesa Hill, has permitted residents to help themselves to slabs for their own yards. The supply has been exhausted at the site. Authorization has been given to the Zia Company to blast out more slabs and it will again be offered without charge.

Technical Information Office Established

Dr. Norris E. Bradbury, director of the Los Alamos Scientific Laboratory, announced the establishment of a Technical Information office in the Documentary division. He also announced the appointment of David M. Stearns of New York City as technical information advisor on the staff of Ralph Carlisle Smith, who is D division leader. Responsibilities of the new office will include: assisting staff members in the preparation of technical publications, supplying unclassified information to the Atomic Energy Commission and other offices outside the Laboratory, and advising the Laboratory staff on procedures involving technical and public information.

what's doing

OUTDOOR ASSOCIATION: No charge, open to the public. Contact leader for information regarding specific hikes.
April 11-15—Havasupai Canyon, Arizona —Ken Ewing, 662-7488.

LOS ALAMOS FILM SOCIETY: April 29—"The Devil's Eye," Civic Auditorium, 7:30 p.m., admission: members—$.75; others $2.00.

RIO GRANDE RIVER RUNNERS: Meetings scheduled for noon, second Tuesday of each month at South Mesa Cafeteria. For information call Cecil Carnes, 672-3539.

NEWCOMERS: April 22, 7:30 p.m., Los Alamos National Bank, "Crime and Narcotics." For information call Judy Ware, 662-5745.

SIERRA CLUB: Luncheon meeting at noon, first Tuesday of each month, South Mesa Cafeteria. For information call Brant Calkin, 455-2468, Santa Fe.

MOUNTAIN MIXERS SQUARE DANCE CLUB: For information call Mrs. Alice Wynne, 662-5964.
April 4—Bud Garrett, Albuquerque, caller, 8 to 11 p.m., Canyon School.
April 18—Harry "Bones" Craig, caller, 8 to 11 p.m., Canyon School.

PUBLIC SWIMMING: High School Pool—Monday through Wednesday, 7:30 to 9 p.m., and Saturday and Sunday, 1 to 6 p.m.; Adult Swim Club, Sunday, 7 to 9 p.m.

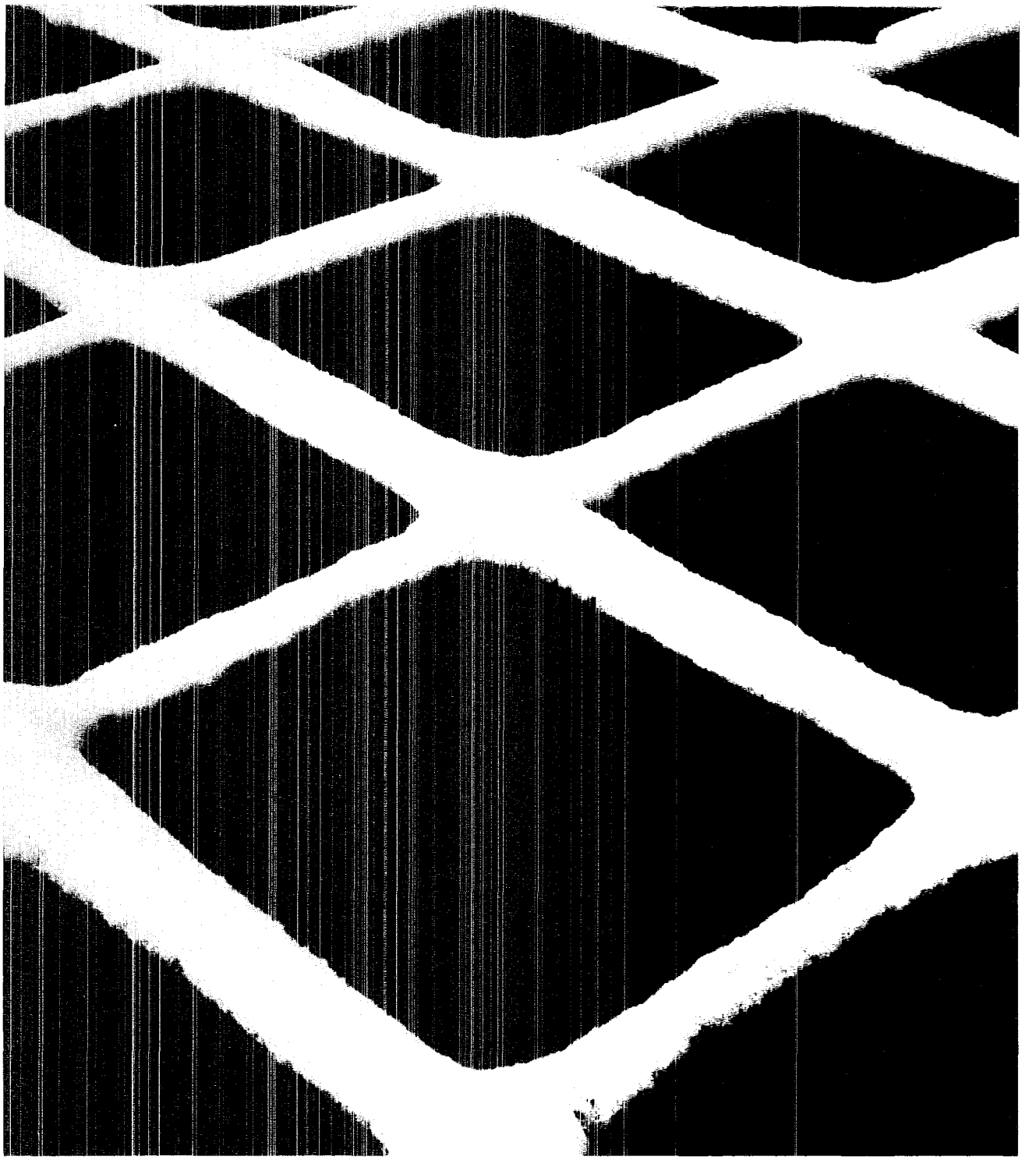
LOS ALAMOS CONCERT ASSOCIATION: April 5, 4 p.m., Fuller's Lodge, humorous concert, "The Animal Kingdom." April 16, 8:15 p.m., Civic Auditorium: Aeolian Chamber Players. Annual membership drive will be held between April 5 and 19. For information call Margaret Hagerman, 662-7389.

BIEN DICHO TOASTMASTERS CLUB: Speechcraft classes begin March 30, South Mesa Cafeteria, noon to 1 p.m. Course on fundamentals and practice of public speaking emphasizing how to organize, prepare and present a speech, conduct meetings and work on committees. For information call C. Mills, 4763.

LOS ALAMOS ARTS COUNCIL: April 26, 7:30 p.m., Fuller's Lodge, chamber music concert.

MESA PUBLIC LIBRARY:
March 19 through April 8—Ukrainian Exhibit—Mrs. Stephanie Sydoriak.
April 1 through April 21—Museum of New Mexico exhibit "Secure Retreats in a Hostile Land." Early photos of New Mexico churches.
April 21 through May 11—Oils by Michio Takayama.

ART EXHIBIT: Paintings of Northern New Mexico by Hal Olsen are on display in the lobby of the Personnel building.



When snow began melting on The Lodge's patio, this interesting winter pattern resulted.

Henry T. Motz
3187 Woodland
Los Alamos, New Mexico
87544

With the help of his 10-year-old daughter, Sona, PUB-1 Photographer Bill Jack Rodgers made this "sandwich" photograph. Sona, with her hands reaching toward the sky, and the March 7 eclipse were photographed separately. In the darkroom, Rodgers sandwiched both negatives together to make this single dramatic picture.